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Characterization and modeling of the randomly distributed ErAs nanoparticles in InGaAlAs semiconductors for thermoelectric power generation JE-HYEONG BAHK, UCSB, MONA ZEBARJADI, ZHIXI BIAN, UCSC, GEHONG ZENG, ASHOK RAMU, HONG LU, UCSB, ALI SHAKOURI, UCSC, ART GOSSARD, JOHN BOWERS, UCSB — We investigate temperature-dependent thermoelectric properties of the InGaAlAs semiconductors containing epitaxially embedded ErAs nanoparticles grown by Molecular Beam Epitaxy. Temperature-dependent Hall measurements and Seebeck coefficient measurements were performed for the materials with various Er concentrations and semiconductor compositions, and the results were analyzed using a theoretical modeling based on the ErAs nanoparticle's carrier scattering behaviors. In the analysis, the nanoparticles are modeled as charged spheres with Schottky barrier height at the interface with semiconductor, and the potential profile around a particle is used as perturbation for electron scattering. The particle scattering rate is calculated using both Born approximation and the partial wave method, respectively, and the two methods are compared to check the validity of Born approximation in various conditions. The theoretical calculation of mobility and Seebeck coefficient based on the modeling of particle scattering and other scattering mechanisms fits the measurement results, and we find that further enhancement of thermoelectric power factor is possible by optimizing the particle scattering in the materials.

Je-Hyeong Bahk
UCSB

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